Claims

1. Electromagnetic device comprising at least one magnetic circuit (1) and at least one electric circuit (2, 3) comprising at least one winding (4, 5), the magnetic and electric circuits being inductively connected to each other and the device comprising a control arrangement (7) to control operation of the device, ***characterized*** in that the control arrangement (7) is adapted to control frequency, amplitude and/or phase as concerns electric power to/from the device by the control arrangement comprising means (9) for controlling the magnetic flux in the magnetic circuit, and that said at least one winding (4, 5) or at least a part thereof comprises at least one electric conductor (42) having an insulation system comprising an electric insulation (44) formed by a solid insulation material and interiorly thereof an inner layer (43), that said at least one electric conductor (42) is arranged interiorly of the inner layer (43) and that the inner layer has an electrical conductivity which is lower than the conductivity of the electric conductor but sufficient to cause the inner layer (43) to operate for equalization as concerns the electrical field exteriorly of the inner layer.

2. A device according to claim 1, ***characterized*** in that the control means comprises at least one control winding (9) inductively connected to the magnetic circuit.

3. A device according to claim 1 or 2, ***characterized*** in that the control arrangement (7) is adapted to control the reluctance in the magnetic circuit.

4. A device according to any preceding claim, ***characterized*** in that the control arrangement is adapted to add a magnetic flux addition to the magnetic flux in the magnetic circuit.

5. A device according to claim 3, ***characterized*** in that material having a permeability greater than 1 is included in the magnetic circuit and that the control arrangement (7) is adapted to control the reluctance in the magnetic circuit by varying the permeability of one or more such zones of the magnetic circuit which have variable permeability.

6. A device according to claim 5, ***characterized*** in that the zone or zones having a variable permeability comprise one or more gaps in the magnetic circuit.

7. A device according to any preceding claim, ***characterized*** in that the magnetic circuit is without magnetic core.

8. A device according to any of claims 1-6, ***characterized*** in that the winding is wound about a magnetic core (6).

9. A device according to claim 2 or one or more of the other claims, ***characterized*** in that the control winding (9) and the winding (4, 5) of the electric circuit are arranged to be passed by substantially the same magnetic flux.

10. A device according to any preceding claim, ***characterized*** in that the device forms a reactor adapted to control, by means of said at least one control winding, frequency, amplitude and/or phase as concerns the electric power flowing in the winding (4, 5) of the electric circuit.

11. A device according to any of claims 1-8 or 10, ***characterized*** in that the electric circuit (2) comprises at least two windings (23, 24) coupled in series, that the magnetic circuit comprises at least two alternative flux paths (18, 19), that said at least one control winding is adapted to control the magnetic flux to pass in any of or both of these flux paths and that the two windings of the electric circuit are located such that one of

them is capable of being switched off from magnetic flux by means of said at least one control winding.

12. A device according to any of claims 1-9 or 11, ***characterized*** in that the magnetic circuit is arranged in the stator or rotor of a rotating electric machine.

13. A device according to any of claims 1-9, ***characterized*** in that the magnetic circuit (1) belongs to a transformer having primary and secondary windings (4, 5) and that the primary and secondary windings and the control winding (9) are arranged to be passed by the same magnetic flux.

14. A device according to any of claims 1-8 in a transformer, ***characterized*** in that the secondary winding of the transformer comprises at least two winding parts coupled in series, that the magnetic circuit comprises at least two alternative flux paths (18, 19), that at least two occurring control windings (9b1, 9b2, 9c1, 9c2) are adapted to control the magnetic flux to pass in one or both of these paths and that the two winding parts of he secondary winding are placed such that one of them is capable of being switched off from magnetic flux by means of the control windings.

15. A device according to any of claims 11 and 14, ***characterized*** in that it comprises a magnetic core having at least three legs coupled in parallel and that two of these legs belong to different flux paths whereas the third is common to the two flux paths.

16. A device according to any preceding claim, ***characterized*** in that the insulation system exteriorly of the insulation comprises an outer layer (45) which has an electrical conductivity which is higher than that of the insulation to make the outer

layer capable, by connection to earth or otherwise a relatively low potential, of operating to equalize potential.

17. A device according to any preceding claim, ***characterized*** in that the outer layer is arranged to substantially enclose the electric field, arising as a consequence of said electrical conductor (42), inwardly of the outer layer (45).

18. A device according to any preceding claim, ***characterized*** in that the inner layer (43) and the solid insulation present substantially equal thermal properties.

19. A device according to any preceding claim, ***characterized*** in that the outer layer (45) and the solid insulation present substantially equal thermal properties.

20. A device according to any preceding claim, ***characterized*** in that said at least one conductor (42) forms at least one induction turn.

21. A device according to any preceding claim, ***characterized*** in that the inner and/or outer layer (43, 45) comprises a semiconducting material.

22. A device according to any preceding claim, ***characterized*** in that the inner layer (43) and/or the outer layer (45) has a resistivity in the range 10^{-6} Ωcm-100 kΩcm, suitably 10^{-3}-1000 Ωcm, preferably 1-500 Ωcm.

23. A device according to any preceding claim, ***characterized*** in that the inner layer (43) and/or the outer layer (55) has a resistance which per length meter of the conductor/insulation system is in the range 50 μΩ - 5 MΩ.

24. A device according to any preceding claim, ***characterized*** in that the solid insulation (44) and the inner layer (43) and/or the outer layer (45) are formed by polymeric materials.

25. A device according to any preceding claim, ***characterized*** in that the inner layer (43) and/or the outer layer (45) and the solid insulation (44) are rigidly connected to each other over substantially the entire interface to ensure adherence also on flexing and temperature change.

26. A device according to any preceding claim, ***characterized*** in that the solid insulation and the inner layer and/or the outer layer are formed by materials having a high elasticity to maintain mutual adherence on strains during operation.

27. A device according to any preceding claim, ***characterized*** in that the solid insulation and the inner layer and/or the outer layer are formed by materials having substantially equal E-modulus.

28. A device according to any preceding claim, ***characterized*** in that the inner layer (43) and/or the outer layer (45) and the solid insulation (44) are formed by materials presenting substantially equal thermal coefficients of expansion.

29. A device according to any preceding claim, ***characterized*** in that the conductor (42) and its insulation system constitutes a winding formed by means of a flexible cable (41).

30. A device according to any preceding claim, ***characterized*** in that the inner layer (43) is in electric contact with the at least one electric conductor (42).

31. A device according to claim 30, ***characterized*** in that said at least one electric conductor (42) comprises a number of strands and that at least one strand of the electric conductor (42) is at least in part uninsulated and arranged in electric contact with the internal layer (43).

32. A device according to any preceding claim, characterized in that the conductor (42) and its insulation system is designed for high voltage, suitably in excess of 10 kV, in particular in excess of 36 kV and preferably more than 72,5 kV.

33. A machine according to claim 12, ***characterized*** in that the magnetic circuit comprises one or more magnetic cores (48) having slots (50) for the winding (41).

34. A device according to any of claims 12 and 32-33, ***characterized*** in that it is constituted of a generator, motor or synchronous compensator.

35. A device according to any of claims 12 and 33-34, ***characterized*** in that it is directly connected to a power network for high voltage, suitably 36 kV and more, without intermediate transformer.

36. A device according to any of claims 1-11 and 13-32, ***characterized*** in that it is constituted by a power transformer/reactor.